Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences

C S A S
Canadian Science Advisory Secretariat

S C C S
Secrétariat canadien de consultation scientifique

Proceedings Series 2006/039

Série des comptes rendus 2006/039

Proceedings of the Maritime Provinces Recovery Potential Assessment of Atlantic Shortfin Mako, White Shark, and Loggerhead Turtle

28–30 November 2006

6th Floor Gully Boardroom
Bedford Institute of Oceanography]
Dartmouth, Nova Scotia

Robert O'Boyle
Meeting Chair

Bedford Institute of Oceanography
1 Challenger Drive, P.O. Box 1006
Dartmouth, Nova Scotia
B2Y 4A2

February 2007

Compte rendu de la réunion du Processus consultatif régional concernant l'évaluation du potentiel de rétablissement du requin-taupe bleu, du requin blanc et de la carette de l'Atlantique

28–30 novembre 2006

Salle de conférences Gully, 6e étage
Institut océanographique de Bedford
Dartmouth (Nouvelle-Écosse)

Robert O'Boyle
Président de réunion

Institut océanographique de Bedford
1, promenade Challenger, C.P. 1006
Dartmouth (Nouvelle-Écosse)
B2Y 4A2

février 2007

Canada

FOREWORD

The purpose of these proceedings is to archive the activities and discussions of the meeting, including research recommendations, uncertainties, and to provide a place to formally archive official minority opinions. As such, interpretations and opinions presented in this report may be factually incorrect or misleading, but are included to record as faithfully as possible what transpired at the meeting. No statements are to be taken as reflecting the consensus of the meeting unless they are clearly identified as such. Moreover, additional information and further review may result in a change of decision where tentative agreement had been reached.

AVANT-PROPOS

Le présent compte rendu fait état des activités et des discussions qui ont eu lieu à la réunion, notamment en ce qui concerne les recommandations de recherche et les incertitudes; il sert aussi à consigner en bonne et due forme les opinions minoritaires officielles. Les interprétations et opinions qui y sont présentées peuvent être incorrectes sur le plan des faits ou trompeuses, mais elles sont intégrées au document pour que celui-ci reflète le plus fidèlement possible ce qui s'est dit à la réunion. Aucune déclaration ne doit être considérée comme une expression du consensus des participants, sauf s'il est clairement indiqué qu'elle l'est effectivement. En outre, des renseignements supplémentaires et un plus ample examen peuvent avoir pour effet de modifier une décision qui avait fait l'objet d'un accord préliminaire.

Proceedings of the Maritime Provinces Recovery Potential Assessment of Atlantic Shortfin Mako, White Shark, and Loggerhead Turtle

28–30 November 2006

6th Floor Gully Boardroom
Bedford Institute of Oceanography]
Dartmouth, Nova Scotia

Robert O'Boyle
Meeting Chair

Bedford Institute of Oceanography
1 Challenger Drive, P.O. Box 1006
Dartmouth, Nova Scotia
B2Y 4A2

February 2007

Compte rendu de la réunion du Processus consultatif régional concernant l'évaluation du potentiel de rétablissement du requin-taupe bleu, du requin blanc et de la carette de l'Atlantique

28–30 novembre 2006

Salle de conférences Gully, 6e étage
Institut océanographique de Bedford
Dartmouth (Nouvelle-Écosse)

Robert O'Boyle
Président de réunion

Institut océanographique de Bedford
1, promenade Challenger, C.P. 1006
Dartmouth (Nouvelle-Écosse)
B2Y 4A2

février 2007

© Her Majesty the Queen in Right of Canada, 2006
© Sa Majesté la Reine du Chef du Canada, 2006

ISSN 1701-1272 (Printed / Imprimé)

Published and available free from:
Une publication gratuite de :

Fisheries and Oceans Canada / Pêches et Océans Canada
Canadian Science Advisory Secretariat / Secrétariat canadien de consultation scientifique
200, rue Kent Street
Ottawa, Ontario
K1A 0E6

http://www.dfo-mpo.gc.ca/csas/

CSAS@DFO-MPO.GC.CA

Printed on recycled paper.
Imprimé sur papier recyclé.

Correct citation for this publication:
On doit citer cette publication comme suit :

DFO, 2006. Proceedings of the Maritime Provinces Recovery Potential Assessment of Atlantic Shortfin Mako, White Shark, and Loggerhead Turtle; 28-29 November 2006. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2006/039.

TABLE OF CONTENTS

SUMMARY / SOMMAIRE iv

INTRODUCTION 1

NORTH ATLANTIC SHORTFIN MAKO 1

Presentation Highlights / S. Campana 1
Discussion 2

NORTH ATLANTIC WHITE SHARK 4

Presentation Highlights / S. Campana 4
Discussion 4

NORTH ATLANTIC LOGGERHEAD TURTLES 6

Presentation Highlights / J. Brazner 6
Discussion 7

CONCLUDING REMARKS 10

REFERENCES 11

APPENDICES 12

Appendix 1. Terms of Reference 12
Appendix 2. List of Participants 14
Appendix 3. Agenda 16
Appendix 4. Recommendations for Further Work 17

SUMMARY

The Maritimes Regional Advisory Process (RAP) review of recovery potential assessments of North Atlantic shortfin mako, white shark, and loggerhead turtles was undertaken at the Bedford Institute of Oceanography (BIO) during 28-30 November 2006. The results of these assessments will be used to inform the listing process and recovery planning for these species.

SOMMAIRE

Dans le cadre du Processus consultatif régional (PCR) de la Région des Maritimes, on a procédé à l'examen des évaluations du potentiel de rétablissement du requin taupe bleu, du requin blanc et de la carette de l'Atlantique nord, à l'Institut océanographique de Bedford, du 28 au 30 novembre 2006. Les résultats de ces évaluations seront transmis aux responsables du processus d'inscription sur la liste des espèces en péril et serviront à la planification du rétablissement de ces espèces.

INTRODUCTION

The Chair, R. O'Boyle, welcomed the participants (Appendix 2) to the meeting. A number of experts on turtle (M. James, D. McAlpine, C. Sasso, and C. Whelan) contributed to the discussion, which significantly enhanced the level of the peer review.

The Terms of Reference (Appendix 1) were summarized, providing the meeting's context and main objectives. In April 2006, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed the status of North Atlantic Shortfin Mako and White Shark as threatened and endangered, respectively. Species so designated are then considered for listing in Schedule I of Canada's Species at Risk Act (SARA). The listing and subsequent recovery plan development requires information on the recovery potential of these species. DFO Science has established a three–phase process to assess recovery potential, including determination of species status, scope for human–induced harm, and mitigation. Each of these has a specific set of objectives as outlined in the Terms of Reference. This meeting was to review analyses of the recovery potential of these species. In addition, COSEWIC had planned to review the status of North Atlantic loggerhead Turtle in May 2007 (although this may change). Typically, Recovery Potential Assessments (RPA) are undertaken after determination of species status by COSEWIC. In this case, the opportunity afforded by this review was taken to consider the recovery potential of loggerhead turtles.

The products of the meeting were to be Canadian Science Advisory Secretariat (CSAS) Science Advisory Reports (SAR) for each species. Also, longer technical Research Documents were to be prepared for shortfin and loggerheads. Given the data paucity, there was no expectation of a research document for white shark. Indeed, the working paper for this species tabled at the meeting consisted of the draft SAR. As will be reported below, SARs were prepared for shortfin and white shark but not loggerheads, and only a research document will be prepared for shortfin mako.

After a review of the Agenda (Appendix 3), the meeting commenced with the presentation of the shortfin mako analysis.

NORTH ATLANTIC SHORTFIN MAKO

Rapporteur: T. Worcester

Campana, S., J. Brazner, and L. Marks. 2006. Recovery Potential Assessment Report on Shortfin Mako Sharks in Atlantic Canada. RAP Working Paper 2006/29.

Presentation Highlights / S. Campana

Evidence was presented from international and U.S. statistics that indicated shortfin mako population abundance in the North Atlantic has declined since the 1970s, but the international statistics suggested that the North Atlantic population has been relatively stable since the late 1980s. Catch rate statistics from the Canadian pelagic longline fleet also indicated relatively stable bycatch rates since the late 1980s, but analysis of length-frequencies indicate that there may have been a decline in the abundance of larger shortfin makos in the Canadian fishery since 1998. Reference points to characterize recovery have not been developed for shortfin mako, but one half the virgin spawning stock biomass (SSB_0) was proposed as a potential

target. Based on an analysis of the proportion of Canadian bycatch relative to international landings, it appears that there is only a small percentage (at most 2-3%) of the North Atlantic population of shortfin makos in Canadian waters at any given time, and that bycatch by foreign fleets in the North Atlantic is the most significant source of mortality for the population. Of the sources of uncertainty that were discussed, uncertainty around estimates of the current population size and trajectory was considered a critical issue and the main reason that population abundance relative to the recovery target is poorly estimated. Monitoring shortfin mako population status in Canadian waters through a fishery-independent shark survey was recommended as a means for obtaining more accurate population estimates.

Discussion

Species Biology

The COSEWIC Designatable Unit (DU) for shortfin is the North Atlantic. This is not being questioned. The discussion focused on the life cycle of shortfin in the North Atlantic and how much of this occurs in Canadian waters. It was noted that much of the information on the migrations of this species is based upon U.S. tagging with only one major tagging study being conducted in Canada. It was pointed out that while some of the major features of shortfin movement (e.g., in Canadian waters in summer–fall months) are known, many are not. For instance, the location of the mating and pupping grounds, while not in Canadian waters, is unknown. Juveniles have been found in the mid-Atlantic, but not near to Canadian waters. There appear to be sex-specific differences in migration patterns, although the specifics are uncertain. Overall, it is a warm water species that, particularly offshore, would be found in association with the Gulf Stream. There was speculation that climate change would likely have impacts on the distribution of the species.

It was noted that in early years (before 1996), shortfin mako might have been reported as porbeagle, a similar looking species, which could account for some of the historical observations in the Gulf of St. Lawrence where makos are less likely to occur.

There was considerable discussion on the potential amount of the species abundance in Canadian waters. The Canadian catch represents 2–3 % of the North Atlantic total. However, this is likely an overestimate due to suspected non-reporting of shortfin in international waters. While this is not adjusted for effort, it is expected that no more than 2–3 % of the North Atlantic shortfin mako population would be in Canadian waters.

There were a number of questions on the life history traits (pup production, weight, growth, maturity at age, generation time, etc.). It was suggested that a table be developed that compared these parameters across shark species. Overall, shortfin are considered more productive than porbeagle but less than blue shark. This has implications for expected recovery times.

Stock Trends and Current Status

It was noted that the International Commission for the Conservation of Atlantic Tunas (ICCAT) analysis of large pelagic longline (LPLL) catch rates in the North Atlantic showed a decline from the 1970s to about the mid-1980s, and relative stability thereafter, consistent with the analysis presented on Canadian LPLL catch rates. Overall, the decline since the 1970s had been about 33%. On the other hand, COSEWIC referred to the catch rate analysis of Baum et al. (2003) in

the Northwest Atlantic, which showed an overall decline of about 40% between 1986 and the present. All these analyses exhibited high variability and different trends by area which could explain the differences. As well, it was pointed out the Japanese fishery operates further offshore and catches larger sharks than the Canadian fishery which may also have contributed to the differences in trends.

There was some discussion on the trends in LPLL effort. In both the North Atlantic and in Canadian waters, effort (number of hooks) had peaked in the early 1990s, and declined since. The international declines were suspected to have been due to reductions in tuna and swordfish quotas.

The shortfin mako size composition in the Canadian LPLL fishery, based upon about 5% observer coverage, shows that this fishery catches small sharks, and that size in the bycatch has been decreasing since 1998. This could be due to a combination of factors, including area of fishing, bait, hook size, and so on. It also may reflect exploitation rates and suggest a decline in abundance of larger makos.

It was asked how reported catches from the observers compared to the landed statistics. No comparison has been undertaken. It was asked what sampling was available for the groundfish fishery bycatch. Shortfin mako in this fishery tend to be smaller than caught by the LPLLs.

Recovery Targets

ICCAT considered an appropriate reference point to be 0.5 of virgin spawning stock biomass, which would be expected to occur if the population was being exploited in equilibrium at Maximum Sustainable Yield (MSY). However, there were large uncertainties in this analysis. This is one of the reference points suggested for porbeagle, the other being 20% of mature female numbers. Without more information, it was agreed to suggest 0.5 SSB_0 as a recovery target which would be at the 'Cautious/Healthy' boundary discussed at a recent national DFO workshop (DFO, 2005).

Recovery Potential

The group agreed that shortfin mako are relatively more productive than porbeagle and that the ICCAT assessment suggests that the species is overall doing better than porbeagle. Therefore, it is expected that recovery of the North Atlantic population would be faster for shortfin than for porbeagle.

Allowable Harm / Provisions of Recovery Plan

Regarding the scope for allowable harm without jeopardizing recovery or survival, there was no model on which to base decisions and thus trends in the available information had to be relied upon. It was pointed out that Canadian catches of just 100t annually did not appear to have any observable impact on the population abundance trajectory but given the uncertainties, it would be prudent not to exceed this level. However, it was also agreed that, due to the small proportion of the population in Canadian waters, it is unlikely that a reduction in bycatch of shortfin makos by the Canadian pelagic longline fishery would have any detectable or biologically significant influence on the population.

Regarding mitigation, fishing is the primary threat to the population and it was not obvious if there were any fishing gear alternatives that could be used to avoid their bycatch (e.g., 75% of the fleet is already using the circle hook). Similarly, there were limited area and spatial controls evident. Overall, there is limited mitigation that Canada can do on its own. It is the impact of the cumulative catch of shortfins across all international fisheries that is resulting in the overall negative impact and requires attention if mitigation is to succeed. It was agreed however, that the Canadian fishery could introduce measures to improve the release of live shortfin. Before introducing this measure, it was suggested that a study be undertaken to determine the percentage of shortfin caught that could be released alive.

The need for more sampling and a fishery independent shark survey to develop an indicator of abundance was highlighted.

NORTH ATLANTIC WHITE SHARK

Rapporteur: W. Joyce

Campana, S. 2006. Draft Recovery Potential Assessment on White Sharks. RAP Working Paper 2006/031.

Presentation Highlights / S. Campana

Evidence was presented that white sharks can migrate long distances, but their movements in the North Atlantic are poorly known. They are found only rarely in Canadian waters, but have typically been seen in August and September when observed. Since 1874, a total of 34 white sharks have been recorded from eastern Canada (two since 1986) and only 15 of these have been captured in commercial fishing gear (e.g., gill nets, herring weirs). Current evidence indicates white shark abundance is declining worldwide. Bycatch data presented from the U.S. longline fleet suggests there has been a sharp decline (between 59 and 89%) in white shark abundance in the North Atlantic between 1986 and 2000. Because of a lack of information on the abundance, distribution, and productivity of the species, as well as insufficient data on bycatch, natural mortality, and reproductive rates, it was concluded that it is not possible to develop models to estimate key population reference points or to assess the potential for the recovery of the North Atlantic white shark population. The high incidence of white shark bycatch in the southern U.S. pelagic longline fleet (more than 400 captures per year on average between 1986 and 2000) appears to be the most significant source of fishery capture and mortality in the North Atlantic, and is not considered sustainable. As a result, it was suggested that the recovery potential in Canadian waters will be mostly dependent on the overall recovery in U.S. and other North Atlantic waters.

Discussion

Species Biology

As with shortfin, it was emphasized that the COSEWIC designable unit is the North Atlantic. However, contrary to shortfin, observations in Canadian waters are very rare, indicating that there is a very low proportion of the population in this region, mostly stray animals, which is different from other shark species. Regarding their productivity, little is known about their growth and mortality rates, although they appear to produce between 2-17 pups and only 4-6 litters,

with a mature female producing only about 45 pups in a lifetime. There is uncertainty as to whether they breed annually. It is difficult to state how productive they are compared to other species although there are indications that they would be similar to porbeagle in this regard.

Stock Trends and Current Status

It was confirmed that ICCAT had not considered the status of white shark. There is limited information on the incidence of white shark encounters over time, which suggests that the population is declining but there is no population size information available to provide corroboration. These sharks are mainly caught accidentally by becoming tangled in nets, longlines, and trapped in fishing weirs, making development of an abundance index based on catch rates impossible. It was pointed out that the declining incidence of white shark in fishing gear could be due to an overall reduction in fishing effort.

There was discussion on considering trends in the encounters in such a marginal area as Canadian waters. Does a decrease in Canadian waters reflect a decrease in population numbers? The consensus was that the frequency of white sharks in Canadian waters is in accordance with the decline seen in world populations.

Recovery Targets

It was mentioned that standard reference points have not been developed for white sharks. It was recommended to use similar reference points used for shortfin and porbeagle but to use numbers rather than weight - the number of female spawners expected in an equilibrium population at maximum sustainable yield (SSN_{msy}).

Recovery Potential

Given the paucity of information on white shark, its recovery potential could not be assessed. It was agreed that there is no known sensitive habitat for white sharks in Canadian waters.

Allowable Harm / Provisions of Recovery Planning

Regarding allowable harm, while there was a lack of information on the status of this species, there was agreement that given their suspected low productivity that there would be no scope for harm of white shark as any level would jeopardize recovery.

Regarding sources of harm and mitigation, potential entanglement with fishing gear (e.g., gillnets, longlines) was mentioned, as was accidental enclosure by herring weirs. However, it was difficult to determine how these impacts could be mitigated against given the accidental and infrequent nature of encounters. Another source of harm mentioned was contaminants which are present in many large pelagic species (e.g., sharks, tunas, swordfishes, whales). However, while it is known that white sharks contain high levels of contaminants like chlorinated hydrocarbons in their tissues, there is no research to demonstrate impacts. Even if this were the case, mitigation would require addressing the source which would be difficult to locate.

It was asked what would happen if a white shark is entangled by fishing gear after being listed. It was noted that SARA has a within-reason clause to protect fishers from accidental entrapment (i.e., if a fisherman were to find a white shark dead in their fishing gear, they would not necessarily be charged). It was suggested that if one should be killed accidentally, then no part

of the animal (including jaws) should be allowed to be kept or sold (illegal trafficking). The only reason any material from these animals should be kept is for scientific study.

NORTH ATLANTIC LOGGERHEAD TURTLES

Rapporteur: R. O'Boyle and D. Kulka

Brazner, J., J. McMillan, L. Marks, and S. Campana. 2006. Recovery Potential Assessment Report for Loggerhead Turtles in NAFO Areas 3 – 6. RAP Working Paper 2006/28.

Presentation Highlights / J. Brazner

An assessment of the status of loggerhead turtle populations in the western North Atlantic was presented. It appears that loggerhead populations are stable or declining slowly in the North Atlantic. Although available trend data is insufficient to make a clear determination, populations are thought to be much reduced from historic levels. Data was presented that suggest Canada's eastern waters, especially off Georges Bank and the Grand Banks, are foraging habitats for a considerable number of loggerhead turtles based on the observed capture of 615 loggerheads in the Canadian pelagic longline fishery (PLF) since 1999. It appears that longline fisheries for tuna and swordfish are among the most important sources of mortality to loggerhead turtles in the western North Atlantic and that bycatch by the Canadian PLF is comparable to what is being taken by the U.S. fleet in recent years. However, despite great uncertainty in the international bycatch estimates, the Canadian bycatch of loggerheads appears to be only about 1% of what is being recorded annually across the entire Atlantic suggesting international efforts to curb loggerhead bycatch will be necessary for recovery efforts to succeed. Scenarios from the best available population models for loggerheads were discussed and they suggest that without reductions of bycatch of pelagic juveniles across the North Atlantic on the order of 10%, population abundance in the western North Atlantic may not be able to achieve and sustain positive growth rates. It appears that there is much that can be done to reduce bycatch by the Canadian PLF, but research is needed to identify the best options and the commercial viability of those options. Data from experimental fisheries by U.S. vessels off the Grand Banks suggests using larger circle hooks (18/0) rather than J hooks baited with mackerel (rather than squid) and fished at temperatures of less than 20°C, is one set of options that look promising. Canadian PLF bycatch data suggests loggerhead injury rates are lower when captured on circle hooks compared to J hooks, so a switch to circle hooks was recommended. The most pronounced difference in loggerhead catch rate was associated with temperature; catch rates above 20°C were much higher than those below 20°C. Concerns about the population effects of marine debris, explosives used in oil exploration, contaminants, and climate change were all discussed but it is currently not possible to quantify the magnitude of these effects. One of the key sources of uncertainty associated with assessing the recovery potential of loggerheads in the western North Atlantic is the lack of information on their sex and size-based movement, abundance, and distribution in Canadian waters. It was suggested that satellite tracking and genetic studies could be used to determine migration routes and nesting origins of loggerheads that use Canadian waters, as well as provide basic ecological data and data on post-release mortality rates.

Discussion

Species Biology

The relative sizes of the five loggerhead subpopulations was discussed. The number of nests per year of each of the five subpopulations estimated in 2001 was:

- northern (North Carolina to Northeast Florida): 7,500
- southern (South Florida): 83,000
- Florida Panama: 1,200
- Yucatan: 1,000
- Dry Tortugas: 200

The assumption is that all five subpopulations could visit Canadian waters in rough proportion to their relative number of nesting sites. It was noted that the proportion of loggerheads encountered in the U.S. northeast fishery that originate from the northern and southern subpopulations are about 25% and 59%, respectively. Given that Georges and the Grand Banks are considered important areas for loggerheads based on the over 600 loggerheads that have been recorded by fisheries observers in these areas since 1999, a sizeable part of the western North Atlantic population could be in Canadian waters at least seasonally. It was mentioned that mitochondrial DNA analysis has been used to differentiate these subpopulations, but microsatellite analysis was suggested as a better tool to use for these purposes.

It was questioned if 35 years of age for maturity was reliable. Most literature will put loggerhead age at maturity around 20-25 years. It was agreed that it would be useful to confirm loggerhead age determination; a collaborative study between Canada and the U.S. using bomb radiocarbon was recommended.

Sex ratios, which are very important to the productivity models, can be extremely variable and are a large source of uncertainty. Nesting female survivorship is also highly uncertain.

Stock Trends and Current Status

It was clarified that stock status is based upon the number of nesting females which is estimated from the number of nests and the average number of nests per female per breeding season (4.1). It was agreed that current trends in the northern subpopulation are unclear, but trend analyses suggest they may be at best stable or more likely declining by 3-5% per year. However, there are clear signs from nest counts that the southern subpopulation is no longer stable or increasing slowly as assessed in 2001, but is now declining with 22% fewer nests observed in 2005 than in 1989. It is not possible to determine whether or not this is part of a natural population cycle. The status of the remaining, smaller, subpopulations is not presently understood, but is expected to be discussed at National Marine Fisheries Service (NMFS) Loggerhead Expert Working Group meetings planned for December 2006 and spring 2007.

Recovery Targets

It was noted that new recovery targets will be reported in a new NMFS and U.S. Fish & Wildlife Services (USFWS) recovery plan for loggerheads and that these will be more specific to individual subpopulations than the 1991 targets. While these were not available at the meeting,

they are expected to be available in late 2007, and it was agreed that they should be used for future recovery planning.

Recovery Potential

It was noted that a new productivity model for the northern and southern subpopulations is being built by Jeannette Wynkeken (Florida Atlantic University) and Selina Heppell (Oregon State University), and that it would be prudent to delay any pronouncements of status and recovery of these subpopulations until this model is available. It was noted that the current model was the most recent in a long pedigree of loggerhead population models that have evolved from one another since 1987. However, the new model will incorporate uncertainties in a stochastic modeling framework, which is a dramatically different approach to the one used for previous models and, along with adjustments to key model parameters, is expected to result in considerably different predictions about population trajectories and recovery probabilities than the earlier models. It was strongly recommended that someone from Canada attend either the December 2006 or spring 2007 NMFS Loggerhead Expert Working Group meetings.

It was confirmed that all the current models assume mitigation efforts being implemented across the entire North Atlantic, e.g., 5% increase in survivorship of pelagic juveniles experienced across all population subcomponents. The general conclusion was that a 10% reduction in pelagic juvenile survival would have a detectable impact on the population. However, this could only be achieved by the joint efforts of all impacting countries so that the 10% reduction was across the entire North Atlantic.

Overall, it was considered prudent to await the new population models before attempting to determine recovery potential.

Allowable Harm / Provisions of Recovery Plan

Regarding sources of harm, there was considerable discussion on the calculation of total loggerhead catches by the Canadian large pelagic fishery. This was based upon the overall catch rate (CPUE) times the number of hooks, which assumes a homogeneous distribution of CPUE throughout the area fished by this fleet. However, there is evidence that indicates that this is not the case. Temperature is known to be influential to loggerhead distributions, with temperatures lower than 15ºC being avoided. This could explain the location of loggerhead catches (near the edge of the Gulf Stream) in comparison to the area of the fishery (Scotian Shelf to Gulf Stream). It was recommended to compare fleet observer coverage with loggerhead catches. Also, it might be possible to use surface temperature information from a variety of sources to stratify an analysis of the CPUE data. It was also noted that loggerhead bycatch CPUE is highest in the yellowfin fishery, compared to the other species being sought and is another factor to consider in the catch analysis. There was some discussion on the appropriate weighting to use in the analysis. It is possible to scale up the observer loggerhead bycatch by the ratio of the observer to total large pelagic catch. Alternatively, it is possible to multiply the loggerhead observer CPUE by the total number of hooks in the fishery. Both methods give similar results except for some years. Choice of which method to use is dependent upon the reliability of the catch and effort data. Opinions varied with some favouring each approach. Overall, it was recommended to redo the catch analysis, stratified by temperature (using data from a variety of sources) to address area and season effects and species sought (yellowfin versus other species). The analysis could lump the data across years as the time series is short. The appropriate weighting of the catch and CPUE should also be examined.

The size composition of loggerhead bycatch in the Canadian longline fishery was discussed. The Canadian large pelagic longline fishery does not appear to catch many loggerheads below 40cm total length. However, the reported catch of large, adult loggerheads was at odds with reports from the U.S. northeast fishery and, if true, would suggest Canadian bycatch may be having a very significant impact on the population. These observations need to be confirmed. It was reported that the observers currently estimate caught loggerhead length visually over the side of the vessel. It was noted that since the new population model assumes fishing impacts primarily immature (not adult) loggerheads, there was further reason to confirm the accuracy of the size-frequency data in Canadian bycatch. It was recommended that a study be undertaken to verify observer at sea measurement of loggerheads. While dip netting and measurement on deck may be the easiest on-board procedure, the study may need to consider new technology (laser sighting) to take the length measurements. Whatever methodology is used, to be comparable to other research on sea turtles, the measurements need to be done by straight carapace length. Also, it would be useful to consider comparable information in adjacent U.S. fisheries. If it is proven that the Canadian observations are suspect, size composition from the U.S. fishery might provide a surrogate for historical Canadian size composition.

There was discussion related to the estimates of post-hooking survival of loggerheads which are currently almost exclusively based upon expert opinion. It was agreed that more work was needed in this area and a recommendation was made to undertake a Canada/U.S. study which would track the fate of injured loggerheads. NMFS already has a study underway in their Northeast Distant Area off the Grand Banks, and U.S. satellite tags might be available for Canada to use in complimentary efforts.

Regarding other sources of harm, seismic activity was considered. However, due to a loggerhead's low hearing capability, the concerns are not as high as for a species such as bottlenose. Seismic vessel strikes might be more important but this could not be determined. Marine debris, explosives at oil platforms, contaminants, and climate change were also mentioned but as was discussed for white and mako sharks, it is exceedingly difficult to determine the level of population impact for these sorts of effects.

Overall, due to the uncertainties on the species recovery potential and levels of harm experienced, it was not possible to evaluate the maximum harm allowable.

A number of potential mitigation measures were discussed to avoid human impacts. Although it was not considered entirely practical, the suggestion was made that fishing could be restricted to fishing areas in which water temperature was below 20°C. Since the peak catch of swordfish and tuna was at around 18°C, and peak catch of loggerheads was about 22°C, there appears to be an opportunity to separate the fishery from the preferred turtle foraging areas to a fair degree. A number of gear modifications were considered even more practical. About 25% of the Canadian fleet still uses the J hook. At a minimum, these vessels should convert to circle hooks since gut hooking (and higher associated mortality) is much less common on circle hooks. The possibility of using the larger 18 circle hook (fleet now uses 16 circle) was discussed. Industry participants at the meeting reported that the 16 circle is used to catch tuna, a fishery in which the loggerhead bycatch is among the highest; at least when the species sought is yellowfin. They felt that the 18 circle hook would result in a drop in tuna catch rates. This was contested by U.S. participants who have not observed this effect in their waters. It was recommended that a study be undertaken to examine the impact on tuna and loggerhead catch rates by moving

from a 16 to 18 circle hook. As a starting point, it was recommended that studies of 16 vs. 18 circle hooks by NMFS researchers in experimental fisheries off the Grand Banks be examined

Potential changes to the depth of the gear operation were discussed. Fishing at depths greater than 40m would avoid the capture of loggerheads but were also expected to have unacceptable reductions in tuna catch rates. This is not a viable option. Similarly, industry participants noted that the swordfish fishery uses primarily mackerel and the tuna fishery squid for bait. Loggerheads do not like mackerel and use of this in the tuna (yellowfin and bigeye) fishery would reduce bycatch. However, industry participants noted that this would also reduce tuna CPUE. At a minimum, recommending exclusive use of mackerel bait in the swordfish fishery would likely provide some reduction in loggerhead bycatch. There have been a number of U.S. studies on the impacts of different bait types on sea turtle bycatch as well the catch numbers of target fisheries species. These should be consulted when considering the management plans for Canadian waters.

There is the potential to develop a loggerhead capture/avoidance protocol as it was mentioned that loggerheads tend to be patchy in distribution. The probability of catching a second loggerhead after catching a first one is higher than catching the first one. Thus, a protocol could be developed that guides the fleet to leave an area once a certain level of loggerhead capture is reached. This would be developed in collaboration with the industry. The most beneficial short term option discussed appeared to be the development of a live hook release kit for fishermen and observers with associated training on its use. The kit includes a large dip net for safely landing turtles so that hooks and gear can be completely removed. It was pointed out that the mortality of turtles is much reduced is all entangling fishing gear has been removed. This has been effectively implemented in the U.S. It was recommended that a similar initiative be undertaken in Canada.

Conclusions and Advice

Given the uncertainties on the biology of loggerheads in Canadian waters, the recommendations to both await completion of a population model currently being developed by turtle researchers and undertake further analyses of the Canadian catch data, it was agreed that the recovery potential assessment for loggerheads would not be completed at this meeting and would be delayed until 2007/08. It was pointed out that COSEWIC may not consider the loggerhead assessment in May 2007, which provides time flexibility to prepare an RPA for the next consideration of loggerheads by COSEWIC. Therefore, the Science Advisory Report for loggerheads was not completed and it was agreed to delay production of a research document as well.

CONCLUDING REMARKS

Following the discussion on the presentations, there was an in-depth review of the two shark draft Science Advisory Reports, during which the text was clarified to ensure that the conclusions of the meeting were faithfully reflected.

The Chair thanked the participants, making particular note of the depth of review afforded by the opportunity of the presence of a number of experts on marine turtles. He noted that a number of very useful and important recommendations for further work had been made that would be summarized in the proceedings (Appendix 4). The meeting was then adjourned.

REFERENCES

Baum, J.K., R.A. Myers, D.G. Kehler, B. Worm, S.J. Harley, and P.A. Doherty. 2003. Collapse and Conservation of Shark Populations in the Northwest Atlantic. Science, 299, 389–392.

DFO, 2005. A Framework for Developing Science Advice on Recovery Targets for Aquatic Species in the Context of the *Species At Risk Act*. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2005/054.

Subsequent to the review of these proceedings, C. Whelan provided a number of papers (published and unpublished) and web links to sea turtle studies conducted by NMFS. On the unpublished reports section of the NMFS Southeast Fisheries Science Center (http://www.sefsc.noaa.gov/seaturtleunpublishedreports.jsp), there are several reports by Watson et al., dealing with the hook/bait field work in the Grand Banks region. Published reports can be found at: http://www.sefsc.noaa.gov/seaturtlepublications.jsp.

Another paper of particular interest is:

Lewison, R.L., S.A. Freeman, and L.B. Crowder. 2004. Quantifying the Effects of Fisheries on Threatened Species: The Impact of Pelagic Longlines on Loggerhead and Leatherback Sea Turtles. Ecology Letters. 7:221-231.

Web links include:

Atlantic Loggerhead Sea Turtle Recovery Plan:
http://www.fws.gov/northflorida/SeaTurtles/loggerhead-recovery/default-loggerhead.htm

NMFS Recovery Plans:
http://www.nmfs.noaa.gov/pr/recovery/plans.htm

NOAA Fisheries – Office of Protected Resources – Marine Turtles:
http://www.nmfs.noaa.gov/pr/species/turtles/

Marine Turtle Recovery Planning:
http://www.nmfs.noaa.gov/pr/species/turtles/conservation/planning.htm

The Sea Turtle Biology and Conservation Symposium abstracts/proceedings are an excellent source of finding the newest reports and information on sea turtle research. While being gray literature, they include all the required contact information to reach the appropriated researchers and managers.
http://www.nmfs.noaa.gov/pr/species/turtles/symposia.htm

APPENDICES

Appendix 1. Terms of Reference

Context

In April 2006, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed the status of Shortfin Mako as Threatened and White Shark as Endangered. Loggerhead Turtle is planned to be assessed in May 2007. Decisions made on permitting of incidental harm and in support of recovery planning need to be informed by the impact of human activities on the species, alternatives and mitigation measures to these and the potential for recovery. An evaluation framework, consisting of three phases (species status, scope for human – induced harm and mitigation) has been established by DFO to allow determination of whether or not SARA incidental harm permits can be issued. To inform decisions relating to listing and recovery planning of the two shark species and potential listing and recovery planning of loggerhead turtle, the meeting will review analyses prepared to meet the objectives stated below.

Objectives

For each Designable Unit:

Phase I: Species Status

1. Evaluate present species trajectory.
2. Evaluate present species status.
3. Evaluate expected order of magnitude/target for recovery.
4. Evaluate expected general time frame for recovery to the target.
5. Evaluate Residence Requirements.

Phase II: Scope for Human – Induced Mortality

6. Evaluate maximum human-induced mortality which the species can sustain and not jeopardize survival or recovery of the species.
7. Document major potential sources of mortality/harm.
8. For those factors NOT dismissed, quantify to the extent possible the amount of mortality or harm caused by each activity.
9. Aggregate total mortality / harm attributable to all human causes and contrast with that determined in task 6.

Phase III: Mitigation and Alternatives

To the extent possible,

10. Develop an inventory of all reasonable alternatives to the activities in task 7, but with potential for less impact. (e.g., different gear, different mode of shipping).
11. Develop an inventory of all feasible measures to minimize the impacts of activities in task 7.

12. Document the expected harm after implementing mitigation measures as described and determine whether survival or recovery is in jeopardy after considering cumulative sources of impacts.

Outputs

- CSAS Science Advisory Report to address all objectives
- CSAS Proceedings of meeting
- CSAS Research Document

Participation

- DFO Maritimes Science
- DFO Maritimes Fisheries Management
- NS and NB representatives
- NS and NB Fishing Industry
- NGOs (WWW and EAC)
- External Reviewers

Appendix 2. List of Participants

Participant Name	Affiliation/Address	Telephone	FAX	E-Mail	[1]Hard Copy Proceedings
Beanlands, Diane	DFO, SARA, BIO	(902) 426-3315		Beanlandsd@mar.dfo-mpo.gc.ca	X
Brazner, John	DFO, Science, BIO	(902) 446-5342		johnbrazner@eastlink.ca	
Campana, Steven	DFO, Science, BIO	(902) 426-3233	(902) 426-9710	campanas@mar.dfo-mpo.gc.ca	
Claytor, Ross	DFO, Science, BIO	(902) 426-4721	(902) 426-1560	claytorr@mar.dfo-mpo.gc.ca	
Cronk, Ron	NB Department of Fisheries	(506) 662-7026	(506) 662-7030		X
Gaetan, Art	Blue Shark Fishing Charters	(902) 830-4115	(902) 465-7508	art@bluesharkcharters.com	
Gosselin, Serge	DFO, Science, IML	(418) 775-0637		Gosselinse@dfo-mpo.gc.ca	
Gregoire, Yves	DFO, Science, IML	(418) 661-3299		Yvesgregorie237@yahoo.ca	
Henneberry, Andy		(902) 868-2112	(902) 868-2105		
Hunt, Linda	DFO, FAM, Marine House	(902) 426-1488	(902) 426-2393	huntl@mar.dfo-mpo.gc.ca	
Hurley, Peter	DFO, Science, BIO	(902) 426-3520	(902) 426-1506	hurleyp@mar.dfo-mpo.gc.ca	
James, Mike	Dalhousie University	(902) 494-6182	(902) 494-3736	mjames@mathstat.dal.ca	
Jones, Brin	Dalhousie University	(902) 426-1846	(902) 426-9710	Jn812211@dal.ca	
Joyce, Warren	DFO, Science, BIO	(902) 426-6382	(902) 426-9710	Joycew@mar.dfo-mpo.gc.ca	
Kulka, David	DFO, Science, NFLD	(709) 772-2064	(709) 772-5469	Kulkad@dfo-mpo.gc.ca	
Lawson, Jack	DFO, Science, NFLD	(709) 772-2285	(709) 772-5461	lawsonj@dfo-mpo.gc.ca	
MacInnis, Gus	Gulf NS Groundfish	(902) 863-4657	(902) 867-1438	Sea.swan.com	
Marks, Linda	DFO, Science, BIO	(902) 426-4435	(902) 426-9710	marksl@mar.dfo-mpo.gc.ca	
McAlpine, Don	New Brunswick Museum	(506) 643-2345	(506) 643-2360	Donald.mcalpine@nbm-mbn.ca	X
McMaster, Andrew	DFO, FAM, Marine House	(902) 426-4766	(902) 426-9683	Mcmastera@mar.dfo-mpo.gc.ca	
McMillan, Jim	DFO, Science, BIO	(902) 426-3516	(902) 426-1506	mcmillanj@mar.dfo-mpo.gc.ca	
Millar, Dave	DFO, Oceans, BIO	(902) 426-9926	(902) 426-3855	millardc@mar.dfo-mpo.gc.ca	

Participant Name	Affiliation/Address	Telephone	FAX	E-Mail	†Hard Copy Proceedings
O'Boyle, Robert (Chairperson)	DFO, Science, BIO	(902) 426-3526	(902) 426-5435	oboyler@mar.dfo-mpo.gc.ca	
Osborne, Derek	DFO, SARA, NFLD	(709) 772-5087	(709) 772-4583	osborned@dfo-mpo.gc.ca	
Reardon, Clary	NS Fisheries	(902 $24-0349	(902) 424-1766	reardonc@gov.ns.ca	X
Sasso, Chris	NMFS, Miami, U.S.	(305) 361-4279	(305) 361-4478	Chris.sasso@noaa.gov	
Schaefer, Heidi	DFO, SARA, BIO	(902) 426-4320		schaeferh@mar.dfo-mpo.gc.ca	
Showell, Mark	DFO, Science, BIO	(902) 426-3501	(902) 426-1506	showellm@mar.dfo-mpo.gc.ca	
Wells, Nadine	DFO, Science, NFLD	(709) 772-8892	(709) 772-6100	wellsn@dfo-mpo.gc.ca	
Whelan, Christie	DFO, Science, Ottawa	(613) 993-1809		whelanchr@dfo-mpo.gc.ca	

† If you require a hard copy of the proceedings, please provide a full mailing address. All others will receive an electronic copy of the proceedings by email.

Appendix 3. Agenda

28 November – Tuesday

09:00 - 09:15	Welcome and Introduction (Chair)
09:15 - 10:00	Shortfin Mako and White Shark (Campana)
10:00 - 10:15	Break
10:15 - 12:00	Shortfin Mako and White Shark continued
12:00 - 13:00	Lunch
13:00 - 15:00	Shortfin Mako and White Shark continued
15:00 - 15:15	Break
15:15 - 17:00	Review of 1st Draft of two shark Science Advisory Reports

29 November – Wednesday

09:00 - 10:00	Loggerhead Turtle (Brazner)
10:00 - 10:15	Break
10:15 - 12:00	Loggerhead Turtle continued
12:00 - 13:00	Lunch
13:00 - 15:00	Review of 1st Draft of Loggerhead Turtle Science Advisory Report
15:00 - 15:15	Break
15:15 - 17:00	Re-analyses & Editing of Science Advisory Reports

30 November – Thursday

09:00 - 12:00	Completion of Review of Science Advisory Reports
12:00	Adjournment

Appendix 4. Recommendations for Further Work

Shortfin Mako and White Shark

- A systematic comparison of the life history characteristics of shark species in Canadian waters be undertaken to better understand the relative productivity of these species.
- A study be undertaken to determine the percentage of shortfin caught that could be released alive by the large pelagic longline fishery.
- There is a need for more sampling of shortfin mako and the implementation of a synoptic fishery independent shark survey to provide indices of abundance.
- Regulations should be put in place to prevent the sale of any part (including jaws) of sharks to prevent illegal trafficking.

Loggerhead Turtles

- A collaborative Canada/U.S. study be undertaken to confirm, using bomb radiocarbon, the age determination of loggerheads.
- Canadian turtle scientists be encouraged to attend the December 2006 NMFS workshop (and followup meeting in early 2007).
- Undertake further analyses of the Canadian large pelagic fishery catches to confirm the estimates of bycatch, using temperature and target species to stratify the analysis; this would also include consideration of the appropriate weighting of catch and effort data as well as maps comparing observer to loggerhead distributions.
- Undertake a study to confirm the at sea determinations of loggerhead length made by observers; it was suggested that new technology might be useful in this project.
- Undertake a collaborative Canada/U.S. study on the post-hooking survival of loggerheads by type of capture.
- Investigate the conversion of the remaining 25% of the Canadian large pelagic fleet to circle hooks.
- Undertake a study to examine the impact on tuna and loggerhead catch rates by moving from a 16 to 18 circle hook.
- Undertake a study on alternative bait choices for reducing sea turtle by catch. (i.e., mackerel instead of squid).
- In collaboration with industry, develop a protocol that would require a vessel encountering loggerheads to move fishing location
- In collaboration with industry, develop a live hook release kit with associated training; this should build upon experience in the U.S. fishery.